Work Plan

DEVELOPMENT OF VERSION THREE OF THE CALIFORNIA INTEGRATED TRANSPORTATION NETWORK (ITN)

Prepared for:
Ms. Cheryl Taylor
Atmospheric Modeling and Support Section
CalEPA- Air Resources Board
Planning and Technical Support Division
1001 I Street
Sacramento, CA

Prepared by:
James G. Wilkinson

Alpine Geophysics, LLC
2076 Westwood Lane
Eugene, OR 97401
(541) 345.2525

14-December-2007

1.0 Introduction

1.1 Background

Currently more than a dozen Metropolitan Planning Organizations (MPOs) as well as the California Department of Transportation (Caltrans) model transportation demand over various components of the California on-road transportation network. These individual networks have been used in past air quality modeling studies to aid in estimating emissions from on-road mobile sources. For urban scale air quality modeling domains (i.e., on the order of 300 km by 300 km), it was feasible to routinely use one or two of these individual networks to help estimate on-road mobile source emissions. However, as the extent of air quality modeling domains has grown to encompass regions on the order of 600 km by 600 km or larger, utilization of individual transportation networks to help estimate on-road mobile source emissions has grown much more difficult.

In an effort to help streamline the process of using the individual transportation networks for use in estimating on-road mobile source emissions estimates, the California Air Resources Board developed the California statewide Integrated Transportation Network (ITN). Version one of the ITN (Wilkinson, 2004), which is a seamless on-road transportation network covering the entire state of California, resulted from the integration of local MPO transportation networks as well as the Caltrans statewide network (Seitz, 2001). Version two of the ITN (Wilkinson, 2006) utilized a new Caltrans statewide network (Adamu, 2004) and incorporated additional MPO transportation networks. Further, ITN v.2.0 incorporated not only link-based networks but also incorporated the polygon-based transportation analysis zone (TAZ) coverages from each network. The inclusion of the TAZ coverages in ITN v.2.0 allowed for the distribution of intrazonal VMT along links in the TAZ contrasted with the treatment of intrazonal VMT as single points (i.e., TAZ centroids) with ITN v.1.0.

Versions one and two of the ITN were used to develop inputs to version four of the Direct Travel Impact Model (DTIM) (Fieber and Ireson, 2001). DTIM coupled with EMFAC2002 (ARB, 2004) were used to estimate on-road mobile source emissions for the Central California Ozone Study (CCOS) (Fujita *et al.*, 2001).

1.2 Purpose

Recognizing the need for improvements to the prior two versions of the ITN, ARB desires to construct version three of the ITN. ITN v.3.0 will take advantage of any recent updates to the MPOs' and CalTrans' travel demand data. Further, ITN v.3.0 will be ported from its current ARC/Info platform to the open source PostgreSQL and PostGIS platforms. PostgreSQL will serve as the data base to house the ITN data, and PostGIS will serve as the GIS platform. In addition, ARB wants to create ITN v.3.0 for the following reasons:

- Improve their ability to conduct quality assurance checks;
- Ensure flexibility in coding for future changes; and
- In the longer term, move the ITN from being a one-point-in-time data storage tool to a data management system from which data can be transferred to transportation-emissions models.

1.3 Work Plan Structure

Section 2 describes the tasks that will be followed to create ITN v.3.0. Section 3 describes the resources and schedule that will be followed to create ITN v.3.0.

2.0 Scope of Work

2.1 Task 1: Use of Older Transportation Data

It is possible that some MPOs/COGs will not have data any newer than what was submitted for use to construct ITN v.2.0. In these instances, we will use those data previously submitted. Again, we will load these data into PostgreSQL tables in the raw_schema. Where future year data were also delivered, said data will be reviewed by ARB staff and the study team to determine if they can be loaded into the system.

Quality Assurance/Quality Control. Once the transportation data are loaded into tables, they will be dumped and delivered for QA/QC to ARB. After ARB has reviewed and modified the data, the study team will import the revised data into a new schema called raw_data_qa under the same table name as stored in the raw_data schema. Also, the data will be projected to the common coordinate standard of longitude-latitude.

Deliverable(s):

Pre-ARB QA/QC

- Raw data as previously obtained from the MPOs/COGs;
- Raw data as previously obtained from the MPOs/COGs in PostgreSQL data base; and
- Link- and TAZ-based volume, trip and VMT summary reports.

Post-ARB QA/QC

- Revised data as previously obtained from the MPOs/COGs;
- Revised data as previously obtained from the MPOs/COGs in PostgreSQL data base; and
- Revised Link- and TAZ-based volume, trip and VMT summary reports.

2.2 Task 2: Collect New Data

ARB desires to update the data in the ITN with the most current modeled data from the COGs and Caltrans. These data are frequently available for multiple years for each region. The study team including ARB will contact the MPOs/COGs to ascertain the availability of new transportation demand modeling files. The study team and ARB will prepare a statement of why these data are needed. We will accept data in any format provided the MPOs/COGs can tell us the structure of the data sets and can tell us the real world coordinate system/map projection parameters or the network conflation characteristics of the data sets.

For the most part, the MPOs/COGs delivered the data in ESRI shapefile format during the development of the ITN v2.0. These data will be loaded as is into PostgreSQL tables to maintain the raw data (PostGIS supplies an easy to use script that loads shapefiles directly into PostgreSQL tables). It is expected that these data will be available in their own PostgreSQL schema named raw_data, where each individual MPO/COG data set will be stored as a separate table within the raw_data schema. It must be noted that because no two MPOs/COGs have the same data structure, each table in the raw_data schema will have different structures. For those transportation model data that are delivered in ASCII files, a perl script will be developed to load these data into PostgreSQL tables. In cases where a COG or MPO delivers transportation model data for multiple years, it will be necessary to carry at least one table attribute (e.g., *version* or *model_year*) to distinguish such data. ARB and the study team will determine how best to manage these multiple years/versions of transportation data from the COGs/MPOs with the PostgreSQL data base.

Quality Assurance/Quality Control. Once the transportation data are loaded into tables, they will be dumped and delivered for QA/QC to ARB. After ARB has reviewed and modified the data, the study team will import the revised data into a new schema called raw_data_qa under the same table name as stored in the raw_data schema. Also, the data will be projected to the common coordinate standard of longitude-latitude.

Deliverable(s):

Pre-ARB QA/QC

- Raw data as obtained from the MPOs/COGs;
- Raw data as obtained from the MPOs/COGs in PostgreSQL data base;
- Link- and TAZ-based volume, trip, and VMT summary reports; and
- Loading scripts or other programs.

Post-ARB QA/QC

- Revised MPOs/COGs data;
- Revised MPOs/COGs in PostgreSQL data base; and
- Revised Link- and TAZ-based volume, trip and VMT summary reports.

2.3 Task 3: Cast Data to Common Format

Once the raw data have passed the study team's and ARB's QA/QC, the data will be cast to a set of commonly formatted PostgreSQL tables in a schema called itn_common_format. ARB and the study team will jointly determine the format of the tables in itn_common_format. These tables will represent the TAZ- and link-based data in a form that is representative of the collective format of the data from the MPOs/COGs. It is already known that the transportation data are in the form of both period-peak (e.g., AM-, PM-, and off-peak such as that from Fresno county) and hourly data such as that available from San Diego. Once the tables have been defined, the tables in raw_data_qa will be cast into the tables in itn_common_format. Of note, one defining characteristic that will be included in this conversion effort is the use of an identifier that will maintain the identity of each link and TAZ record in the common record with the original link and TAZ record from the tables in the schema raw_data_qa. This will allow the user to make a direct connection from the common data to the original data as submitted by the MPOs/COGS. Multiple pgpsql scripts will likely need to be developed to cast the data to a common format. Once in a common format, it should be possible to develop individual scripts to perform like tasks (e.g., treatment of travel volumes and trips crossing from one network to another, treatment of missing data) across the multiple networks. Further, when moving the data to a common format, efforts will be taken to cast like data with different coding schemes (e.g., facility type) to a common coding structure.

ARB desires to restructure the data base files for more flexibility and efficiency. For each region, some options that ARB wants the study team to consider include the following:

- Populate a single attribute file with the original raw COG data temporal and vehicle class detail both for TAZ and link data.
- Separate VMT data from volume and speed data. For TAZ files, populate productions and attractions in attribute files separate from interzonal volumes.
- Store additional information in separate tables that might be present in the MPO/COG submittals.

In previous ITN development efforts, the study team prepared an ARC AML script to cast volume and trip data to a common year. For the next version of the ITN, this effort will not be undertaken. Instead, a new pgpsql script will be developed so that a user can extract a specific year of data. If that specific year of data does not exist, then the pgpsql script will apply an appropriate backcast/forecast method.

Backcasting and forecasting of trips and volumes data of past versions of the ITN were based on historical and projected US Federal Highway Administration Highway Performance Monitoring System (HPMS) VMT data and US EPA VMT data (FHwA 2001a, b, c, d, e; USEPA 2001). Because these VMT data were developed at the county level, volume and trips for every vehicle class on every link and TAZ were grown by an equal factor. That is, there was no link- or TAZ-specific growth factor variation.

In the next version of the ITN, ARB and the study team will explore alternative methods to backcast and forecast transportation network data. It is possible, for example, that backcasting and forecasting might be based on interpolation between multiple calendar years COG data submittals. It is also possible to base backcast and forecast data on information taken from EMFAC.

With version one of the ITN, weekend day factors were developed and applied to the weekday ITN data such that weekend day VMT, volumes, and trips were estimated. Further, the diurnal variation of weekend day VMT, volumes, and trips were adjusted to reflect suspected hourly on-road mobile source activity. This was not done with version two of the ITN given that there was on-going research at ARB to develop new factors to estimate weekend day on-road mobile source activity. If this research is sufficiently advanced such that we can use these weekend day and weekday adjustment factors, we will attempt to incorporate such data to the extent that project resources permit.

<u>Quality Assurance/Quality Control</u>. Once the data are in a common format, the PostgreSQL tables will be dumped and delivered to ARB for its inspection. Errors identified by ARB will be corrected directly within the pgpsql/perl scripts and within the PostgreSQL tables stored in the itn_common_format schema.

ARB will also QA the data once they have been cast to a common year. Errors identified by ARB will be corrected within the pgsql/perl scripts and within the PostgreSQL tables stored in the itn_common_format schema.

Deliverable(s):

<u>Pre-ARB QA/QC</u>

- Common formatted data (not QAed and not cast to a common year) in PostgreSQL data base schema itn_common_format; and
- Link- and TAZ-based volume, trip and VMT summary reports.

<u>Post-ARB QA/QC</u>

- Common formatted data (cast to a common year) in PostgreSQL data base schema itn_common_format; and
- Revised link- and TAZ-based volume, trip and VMT summary reports.

2.4 Task 4: Extract EMFAC Data

The study team (i.e., Alpine Geophysics) will extract data representing the hourly vehicle mix, hourly trip counts, and hourly speeds from a version of EMFAC determined by ARB. Though these data can be used to split the MPO/COG transportation data into hourly, vehicle type-specific volume and trip estimates, it is not clear whether ARB desires to pursue automatic disaggregation of the transportation data into hourly values. ARB and the study team will discuss what needs to be done in terms of temporalization of the transportation data.

The study team (i.e., Alpine Geophysics) will reformat these EMFAC data from EMFAC-specific formats to ASCII files formatted for use in this study. The formats of these ASCII files are shown in Tables 2-1 through 2-3. Pending the outcome of ARB's and the study team's discussions on temporalization, the formats of Tables 2-1 through 2-3 may change. These data will be imported into appropriate PostgreSQL tables in a schema named emfac for use in subsequent processing of the transportation data. Once these data are in PostgreSQL tables, the data will be dumped and delivered to ARB for QA.

Table 2-4 lists the currently acceptable EMFAC2007 vehicle classes. As history has shown, changes in EMFAC over the course of time have resulted in additions/changes to the vehicle class category. In order to maintain such changes over the course of time, Table 2-4 has been added. Given that ARB desires to track such changes, other PostgreSQL tables may also need to carry the "EMFAC version" attribute. This will be determined during the course of the study.

Table 2-1. Default hourly vehicle mix from EMFAC.

Attribute	Type	Description
EMFAC version	A	Version of EMFAC
state fips	I	state FIPS code (should always be 06 for California)
county fips	I	county FIPS code
year	I	year of EMFAC data
month	I	month of EMFAC data (01-12)

Attribute	Type	Description
vehicle class	I	Valid vehicle classes 01 – passenger car 02 – light-duty trucks (T1) 03 – light-duty trucks (T2) 04 – medium-duty trucks (T3) 05 – light heavy-duty trucks (T4) 06 – light heavy-duty trucks (T5) 07 – medium heavy-duty trucks (T6) 08 – heavy heavy-duty trucks (T7) 09 – other buses 10 – urban bus 11 – motorcycle 12 – school bus 13 – motor homes
f01-f24	F	hourly VMT fractions

Table 2-2. Default hourly trip counts from EMFAC.

Attribute	Type	Description
EMFAC version	A	Version of EMFAC
state fips	I	state FIPS code (should always be 06 for California)
county fips	I	county FIPS code
year	I	year of EMFAC data
month	I	month of EMFAC data (01-12)
vehicle class	I	Valid vehicle classes 01 – passenger car 02 – light-duty trucks (T1) 03 – light-duty trucks (T2) 04 – medium-duty trucks (T3) 05 – light heavy-duty trucks (T4) 06 – light heavy-duty trucks (T5) 07 – medium heavy-duty trucks (T6) 08 – heavy heavy-duty trucks (T7) 09 – other buses 10 – urban bus 11 – motorcycle 12 – school bus 13 – motor homes
fuel type	I	Valid fuel types 01 – gasoline 02 – diesel 03 – electric
t01-t24	F	hourly trip counts

Table 2-3. Default hourly speeds from EMFAC.

Attribute	Type	Description
EMFAC version	A	Version of EMFAC
state fips	I	state FIPS code (should always be 06 for California)
county fips	I	county FIPS code
year	I	year of EMFAC data
month	I	month of EMFAC data (01-12)

Attribute	Type	Description
vehicle class	I	Valid vehicle classes 01 – passenger car 02 – light-duty trucks (T1) 03 – light-duty trucks (T2) 04 – medium-duty trucks (T3) 05 – light heavy-duty trucks (T4) 06 – light heavy-duty trucks (T5) 07 – medium heavy-duty trucks (T6) 08 – heavy heavy-duty trucks (T7) 09 – other buses 10 – urban bus 11 – motorcycle 12 – school bus 13 – motor homes
fuel type	I	Valid fuel types 01 – gasoline 02 – diesel 03 – electric
s01-s24	F	hourly speeds (miles per hour)

Table 2-4. EMFAC vehicle classes by EMFAC version.

Attribute	Type	Description
EMFAC version	A	Version of EMFAC
vehicle class	I	Valid vehicle classes 01 – passenger car 02 – light-duty trucks (T1) 03 – light-duty trucks (T2) 04 – medium-duty trucks (T3) 05 – light heavy-duty trucks (T4) 06 – light heavy-duty trucks (T5) 07 – medium heavy-duty trucks (T6) 08 – heavy heavy-duty trucks (T7) 09 – other buses 10 – urban bus 11 – motorcycle 12 – school bus 13 – motor homes
description	A	long description of vehicle class

Quality Assurance/Quality Control. Once the EMFAC data are in PostgreSQL tables, they will be dumped and delivered to ARB for its inspection. Errors identified by ARB will be logged so that ARB staff responsible for EMFAC are alerted to potential deficiencies. Where ARB so directs, the study team will correct EMFAC data directly within the PostgreSQL tables.

Deliverable(s):

Pre-ARB QA/QC

- PostgreSQL tables of EMFAC data.

Post-ARB QA/QC

- PostgreSQL tables of EMFAC data with corrections per ARB's direction.

2.5 Task 5: Combine Data to Create ITN v.3.0

Following methods established to construct versions one and two of the ITN (Wilkinson, 2004, 2006), ITN v.3.0 will be created. ARB will need to decide if effort will be spent to align the roadways from different networks (e.g., Interstate 5 as it traverses Kings County to Fresno County). ARB and the study team will jointly determine the PostgreSQL table structures in which the new ITN data will be stored. These tables will be stored in the PostgreSQL data base schema itn. The study team will also make use of the gravity model (Wilkinson, 2004, 2006) to add commercial truck traffic volumes to the CalTrans network.

Network matching is an area that will receive particular attention. As the COG/MPO networks are meshed together, there will be the need to ensure that the links are properly joined at the network boundaries (e.g., I-5 in Fresno County properly joins I-5 in Kings County). In version one of the ITN, the networks were manually meshed together. A manual adjustment of the links will also likely be necessary to mesh the networks at the adjoining boundaries for the third version of the ITN. Further, ARB and the study team will determine the best method to reconcile the internal-external, external-internal, and external-external trips and volumes.

<u>Quality Assurance/Quality </u>Control. Once the new ITN has been created, the PostgreSQL tables will be dumped and delivered to ARB for its QA. Errors identified by ARB will be corrected directly within the pgpsql/perl scripts and within the PostgreSQL tables stored in the itn schema.

One area of specific emphasis that will be considered by ARB is the method that will be used to distribute commercial truck travel to the CalTrans network. This will require that ARB review the gravity model.

Another area that ARB will specifically review is the methods used to select/delete external-external volumes and external-internal volumes.

Deliverable(s):

<u>Pre-ARB QA/QC</u>

- PostgreSQL tables of ITN data;
- pgpsql, perl, and AutoIt scripts used to create ITN and intermediate data sets; and
- Microsoft Excel-based gravity model updated with current data.

<u>Pre-ARB QA/QC</u>

- Revised PostgreSQL tables of ITN data;
- Revised pgpsql, perl, and AutoIt scripts used to create ITN and intermediate data sets; and
- Revised Microsoft Excel-based gravity model updated with current data.

2.6 Task 6: Reporting and Project Management

Dr. Wilkinson will be the Principal Investigator for this effort. Though he will perform much of this work, he may utilize the talents of Ms. Cynthia Loomis to perform some aspects of the study. Monthly progress reports will be submitted for review by ARB. Alpine Geophysics will email ARB weekly to provide details about any unresolved issues. Alpine Geophysics and ARB will have conference calls two times per month to discuss project details. A draft and final report regarding this effort will be prepared.

Other Issues to Consider

- Can the ITN be used to estimate activity for non-typical days (e.g., holidays)?
- As transportation activity data become more spatially and temporally resolved, can the new PostgreSQL-PostGIS system be adapted to capture these data?
- How might the results of speed post-processors be incorporated into the new PostgreSQL-PostGIS framework?

Deliverable(s):

- Monthly progress reports;
- Weekly emails to detail unresolved issues;
- Twice monthly conference calls; and
- Draft and final reports.

3.0 Budget and Schedule

Table 3-1 shows a schedule of deliverables. If the project were to start 01-Jan-2008, it is projected to be complete 12-Sep-2008. Table 3-2 shows the proposed budget by Task. The total proposed budget is $70,994.

Table 3-1. Schedule of deliverables.

Task	Deliverable	Due Date	Comment
1	Raw data as previously obtained from the MPOs/COGs	11-Jan-2008	
1	Raw data as previously obtained from the MPOs/COGs in PostgreSQL data base	25-Jan-2008	
1	Link- and TAZ-based volume, trip and VMT summary reports.	01-Feb-2008	
1	Task 1data to ARB for QA/QC	01-Feb-2008	ARB has three weeks to review (expected return date 22-Feb-2008)
4	PostgreSQL tables of EMFAC data.	01-Feb-2008	
4	Task 4 data to ARB for QA/QC	01-Feb-2008	ARB has three weeks to review (expected return date 22-Feb-2008)
4	Task 4 Post-ARB QA/QC data	29-Feb-2008	
2	Raw data as obtained from the MPOs/COGs	07-Mar-2008	
1	Task 1 Post-ARB QA/QC data	14-Mar-2008	
2	Raw data as obtained from the MPOs/COGs in PostgreSQL data base	21-Mar-2008	
2	Link- and TAZ-based volume, trip, and VMT summary reports.	11-Apr-2008	
2	Loading scripts or other programs	11-Apr-2008	
2	Task 2 data to ARB for QA/QC	11-Apr-2008	ARB has three weeks to review (expected return date 02-May-2008)
3	Common formatted data (not QAed and not cast to a common year) in PostgreSQL data base schema itn_common_format	25-Apr-2008	
3	Link- and TAZ-based volume, trip and VMT summary reports.	02-May-2008	
3	Task 3 data to ARB for QA/QC	02-May-2008	ARB has three weeks to review (expected return date 23-May-2008)
2	Task 2 Post-ARB QA/QC data	16-May-2008	
3	Task 3 Post-ARB QA/QC data	30-May-2008	
5	PostgreSQL tables of ITN data	02-Jul-2008	
5	pgpsql, perl, and AutoIt scripts used to create ITN and intermediate data sets	11-Jul-2008	
5	Microsoft Excel-based gravity model updated with current data.	11-Jul-2008	
5	Task 5 data to ARB for QA/QC	11-Jul-2008	ARB has four weeks to review (expected return date 08-Aug-2008)
5	Task 5 Post-ARB QA/QC data	15-Aug-2008	
6	Monthly progress reports	Varies	
6	Email every Thursday to detail unresolved issues	Every Thursday	
6	Twice Monthly Conference Calls	2nd and 4th Wednesday	
6	Draft Final Report	22-Aug-2008	Two weeks for ARB review
6	Final Report	12-Sep-2008	

Table 3-2. Proposed budget.

ARB ITN v.3.0 (Version 1.0 28-Sep-2007)		Task 1 Use Old Data		Task 2 Collect New Data		Task 3 Cast to Common Format and Year		Task 4 Extract EMFAC Data		Task 5 Create ITN v.3.0		Task 6 Reporting & Management		Total	
Alpine Labor	Rate	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount
Dr. James G. Wilkinson	$147.29	44	$6,481	84	$12,372	110	$16,202	40	$5,892	140	$20,621	64	$9,427	482	**$70,994**
Subtotal Labor		*44*	*$6,481*	*84*	*$12,372*	*110*	*$16,202*	*40*	*$5,892*	*140*	*$20,621*	*64*	*$9,427*	*482*	**$70,994**
ODCs															
Travel (Air, Land, Sea)			$0		$0		$0		$0		$0		$0		**$0**
Lodging			$0		$0		$0		$0		$0		$0		**$0**
Meals			$0		$0		$0		$0		$0		$0		**$0**
Mailing			$0		$0		$0		$0		$0		$0		**$0**
Computer			$0		$0		$0		$0		$0		$0		**$0**
Subtotal ODCs			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		**$0**
G&A	10%		$0		$0		$0		$0		$0		$0		**$0**
Fee	3%		$0		$0		$0		$0		$0		$0		**$0**
TOTAL BUDGET		**44**	**$6,481**	**84**	**$12,372**	**110**	**$16,202**	**40**	**$5,892**	**140**	**$20,621**	**64**	**$9,427**	**482**	**$70,994**

4.0 References

Adamu, A. (2004). Memorandum and data submittal to Alpine Geophysics, LLC. California Department of Transportation, Transportation System Information, Sacramento, CA. 20 October.

ARB, 2004. "EMFAC2002 Release." 06 April. www.arb.ca.gov/msei/on-road/latest_version.htm

BTS, 1999. "Transportation Statistics Annual Report 1999." US Department of Transportation, Federal Highway Administration, Bureau of Transportation Statistics. 199.79.179.77/transtu/tsar/tsar1999/

BTS, 2000. "Transborder Surface Freight Data, Monthly and Annual Detail Data." US Department of Transportation, Federal Highway Administration, Bureau of Transportation Statistics http://199.79.179.77/ntda/tbscd/prod.html

Caltrans, 2002a. "2000 Truck AADT." California Department of Transportation, Traffic and Vehicle Data Systems Unit. www.dot.ca.gov/hq/traffops/saferesr/trafdata/.

Caltrans, 2002b. "Historical Monthly VMT, 1972-2000." California Department of Transportation, Traffic and Vehicle Data Systems Unit. www.dot.ca.gov/hq/traffops/saferesr/trafdata/monthly/histdata.pdf

ESRI, 1998. ARC/INFO. www.esri.com/software/arcinfo/index.html. Environmental Research Systems Institute, Inc.

FHwA, 2001a. "1995 Highway Statistics." Federal Highway Administration, Office of Highway Information Management. www.fhwa.dot.gov/ohim/1995/section5.htm

FHwA, 2001b. "1996 Highway Statistics." Federal Highway Administration, Office of Highway Information Management. www.fhwa.dot.gov/ohim/1996/section5.html

FHwA, 2001c. "1997 Highway Statistics." Federal Highway Administration, Office of Highway Information Management. www.fhwa.dot.gov/ohim/hs97/roads.htm

FHwA, 2001d. "1998 Highway Statistics." Federal Highway Administration, Office of Highway Information Management. www.fhwa.dot.gov/ohim/hs98/roads.htm

FHwA, 2001e. "1999 Highway Statistics." Federal Highway Administration, Office of Highway Information Management. www.fhwa.dot.gov/ohim/hs99/roads.htm

FHwA, 2000. National Highway Planning Network. United States Department of Transportation, Federal Highway Administration. www.fhwa.dot.gov/planning/nhpn/

Fieber, J. L. and R. G. Ireson. 2001. "DTIM4 User's Guide." Manual updated by Wayne Luney. Prepared by ICF Kaiser Consulting Group, Systems Application International, 101 Lucas Valley Road, San Rafael, CA. Prepared for California Department of Transportation, Office of Travel

Forecasting and Analysis, PO Box 942874 (MS-38), Sacramento, CA (wayne.luney@dot.ca.gov).

Fujita, E., D. Campbell, R. Keislar, J. Bowen, S. Tanrikulu and A. Ranzieri (2001). "Central California Ozone Study – Volume III: Summary of Field Operations." Final Report prepared by the Division of Atmospheric Science, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512 and Bowen Planning and Technical Support Division, California Air Resources Board, Sacramento, CA 95812. February 5. www.arb.ca.gov/airways/ccos/docs/ccosv3fdS0.zip

Lam, T., D. Niemeier, and K. Jierranaitanakit, 2002. "Estimation of Hourly Allocation Factors for the Central California Ozone Study Using State-wide Model Data and Real Time Traffic Data." Final Draft Prepared for California Air Resources Board, 2020 L Street, Sacramento, CA 95812-2815. Prepared by Department of Civil and Environmental Engineering, University of California, One Shields Ave., Davis, CA 95616. July.

MTC, 2004. "Appendix B: Travel Forecasting Assumptions, 2001 Update of the San Francisco Bay Area Regional Transportation Plan." ftp://198.31.87.7/pub/mtc/planning/forecast/Assumptions2001.zip

NCHRP, 1998. "Report 365: Travel Estimation Techniques for Urban Planning." National Cooperative Highway Research Program. Transportation Research Board, National Academy Press, Washington, DC.

SAS, 1998. The SAS System. www.sas.com/software/sas_system. SAS Institute, Inc.

Seitz, L., 2001. Personal Communication. California Department of Transportation (Caltrans). (e-mail) 8-June.

USDOT, 1996. "The Travel Mode Improvement Program. Quick Response Freight Manual (Final Report)." Prepared for the Federal Highway Administration, Office of Planning and Environment, Technical Support Services for Planning Research. Prepared by Cambridge Systematics, Inc., Comsis Corporation, and the University of Wisconsin at Milwaukee. DTFH61-93-C-00075 and DTFH61-93-C-00216. September. tmip.fhwa.dot.gov/clearinghouse/docs/quick/

USEPA (2001). "VMT Growth Factors (%) By County: California." www.epa.gov/ttn/naaqs/ozone/areas/vmt/vmtcagf.htm

Wilkinson, J. G. (2004). "Development of the California Integrated Transportation Network (ITN)." Final report prepared for Vernon Hughes, Manager, Control Strategy Modeling Section, CalEPA- Air Resources Board, Planning and Technical Support Division, 1001 I Street, Sacramento, CA. Prepared by Alpine Geophysics, LLC, La Honda, CA. ARB Contract 93-2PM. AG Report AG-TS-90/155.

Wilkinson, J. G. (2006). "Development of Version Two of the California Integrated Transportation Network (ITN)." Final report prepared for Vernon Hughes, Manager, Control Strategy Modeling Section, CalEPA- Air Resources Board, Planning and Technical Support

Division, 1001 I Street, Sacramento, CA. Prepared by Alpine Geophysics, LLC, Eugene, OR. ARB Contract 93-2PM. AG Report AG-TS-90/210.